(Formerly)

Automatic Dependent Surveillance -Broadcast (ADS-B)

(Currently)

Enhanced Surveillance Capability

Mission Need Statement #326

May 2001

1.0 ADMINISTRATIVE INFORMATION

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The Enhanced Surveillance Capability Mission Need Statement (MNS) statement was originally called Automatic Dependent Surveillance – Broadcast (ADS-B); however, the MNS title was modified to reflect the impacts the applications of this technology has on current surveillance capability.

2.0 DESCRIPTION OF THE MISSION NEEDS

In the early 1980's, civil aviation recognized the increasing limitations of the present communications, navigation, surveillance (CNS) and air traffic management (ATM) systems, the need to make improvements to overcome those limitations, and to meet future needs. To fulfill its vision and commitments to the global air traffic control system, the FAA must evaluate its present air traffic management (ATM) system and plan for future capabilities.

While current surveillance technology is generally adequate for today's environment, it will not support the anticipated growth in aviation without loss of efficiency within the NAS. As the request for additional services increases—including traffic demand—system inefficiencies will occur causing delays and restrictions across the NAS thereby increasing cost and reducing airspace users' ability to meet customer demands. There is a need to improve the Federal Aviation Administration's (FAA) surveillance capabilities in the terminal, en route and oceanic airspace environments and on the airport surface to sustain the current levels of safety and increase efficiency. Surveillance methods used in today's environment will not support continued aviation growth. Additionally, the current surveillance systems do not take advantage of new technologies in navigation, communication and flight management. Expansion of surveillance coverage is essential to support air traffic control modernization efforts.

The *Final Report of RTCA Task Force 3 Free Flight Implementation* and the government/industry concept for the evolution of Free Flight clearly establishes the need for surveillance improvements in order to achieve the benefits of Free Flight. The documents clearly call for improved airspace efficiency, capacity, and safety through reduced separation. In 2000, the RTCA Free Flight Select Committee's Surveillance Working Group prepared two documents: *Joint Government/Industry Surveillance Operational Concept for Free Flight Enhancements* and the *Joint Government/Industry Roadmap for Surveillance Modernization.* The Roadmap outlines the current surveillance systems need for improved aviation safety, capacity and efficiency and highlights a set of target architecture characteristics. This document states that reliance on Automatic Dependent Surveillance-Broadcase (ADS-B) as the "cornerstone" of the future surveillance system is fundamental to the operational concept. Both documents discuss ADS-B as well as other surveillance support capabilities necessary forimproved surveillance within the NAS.

The purpose of this MNS is to exploit a technological opportunity that enhances the Federal Aviation Administration's (FAA) surveillance capabilities in the terminal, en route, and oceanic airspace environments and the airport surface area. The technology is identified as ADS-B. ADS-B systems broadcast and receive ADS-B messages containing information such as: the identification of the broadcast system, its position (latitude/longitude), altitude, speed, heading and other information. By incorporating the enhanced surveillance information into the FAA's Air Traffic Control (ATC) automated data tracking systems, the surveillance capabilities of the National Airspace System (NAS) are significantly increased/enhanced. This MNS can contribute to the promotion of global airspace interoperability and commerce.

Enhanced Surveillance applications of ADS-B technology is evolving in three areas:

a. **Air-to-Air**. Enhanced Surveillance equipped aircraft can safely locate, identify, and display the positions of other enhanced surveillance equipped aircraft in relation to their own aircraft, enhancing situational awareness and safety. Enhanced surveillance equipped aircraft are capable of seeing other equipped traffic in an air-to-air environment. This capability will allow for operational enhancements to include improved terminal operations in low visibility; enhanced see and avoid; enhanced en route operations with pilot situational awareness beyond visual range; conflict airborne management detection, prevention and resolution; and enhanced surveillance in non-radar airspace. The FAA and industry is currently testing and evaluating various applications for each of these enhancements. Fixed obstructions to flight such as broadcasting towers, mountain tops, etc. can be electronically "seen" by enhanced surveillance equipped aircraft by placing an ADS-B transmitter on the obstacle and broadcasting the obstacle's position and altitude. This can also be done for other types of flying objects, such as balloons, unmanned vehicles, and space flight vehicles. Initially, enhanced surveillance will be used for air-to-air operations.

b. **Airport surface**. In the airport surface movement area, this enhanced surveillance allows controllers, pilots and airport vehicle operators to electronically "see", identify, monitor, and track the position and movement of all other enhanced surveillance equipped aircraft and vehicles operating in the area, including aircraft taking off and landing in all weather conditions. Applications for the prevention of runway incursions and airport movement incidents using this enhanced surveillance information are being investigated through the Airport Surface Movement Enhancement and Runway Incursion Prevention MNS #323, referred to as the "Runway Incursion Program."

c. **Air-to-ground**. ADS-B equipped aircraft can information to ground receivers and relay this data to Air Traffic Control (ATC) personnel and/or airline operations centers. The enhanced positional accuracy and higher update rate of this enhanced surveillance data (compared to radar data), as well as additional information content such as call sign, speed, and vehicle intent, provide an enabling technology to enhance aviation safety and increase airspace capacity over what has been achievable using existing radar-based technology. In addition, ADS-B technological applications can provide enhanced surveillance coverage in areas that currently have no radar coverage. It can also be used to extend or replace current surveillance capabilities. Air-to-ground enhanced surveillance can greatly assist controllers and airline operations centers with airspace management when the more accurate and timely ADS-B data is integrated into Traffic Flow Management (TFM) capabilities.

2.1 Integration. The integration of this enhanced surveillance information augments:

a. Airspace surveillance (terminal, en route and oceanic)

b. Airport surface surveillance

c. Airspace capacity (terminal, en route and oceanic)

d. Airport capacity

e. Controller, pilot and vehicle operator situational awareness

f. Safety of aviation activities

g. Implementation and integration of Free Flight activities.

The current FAA ATC system provides surveillance services via a network of ground-based radar systems in the NAS. A radar system typically encompasses 360 degrees with maximum range of 250 miles for en route and usually 60 miles for terminal. Primary and beacon data [Air Traffic Control Beacon Interrogator (ATCBI)/Mode S systems] is provided to the ATC automation systems. Throughout the continental U.S., the en route NAS generally has beacon coverage at 10,000 feet and above ground level except in mountainous terrain where the base coverage varies. Terminal radar surveillance generally extends from the surface to 20,000 feet. At some 34 identified terminal locations, airport surface surveillance will be provided by Airport Surface Detection Equipment (ASDE-3).

Radar systems are strategically located with some coverage overlap to provide a two-dimensional airspace picture to air traffic controllers and air traffic management. Controllers monitor, control, and separate air traffic based on the data received from this network and displayed at their radar control position. Traffic management uses the data to dynamically adjust traffic flows. Controllers and traffic managers can only provide service based on the accuracy and adequacy of the radar coverage.

Radar surveillance coverage is affected by obstacles, (i.e., trees, buildings, towers, objects and terrain). These obstacles cause blind spots or areas of non-surveillance coverage. Surveillance ATC services by FAA facilities outside the continental U.S. are limited by the availability of radar systems and the range of the systems. The oceanic airspace areas where the FAA provides ATC services do not have surveillance coverage, i.e., New York and Oakland Oceanic Control Centers (OCC) and Houston Air Route Traffic Control Center (ARTCC) for the Gulf of Mexico.

Expansion of surveillance coverage is essential to support the FAA's ATC modernization efforts. The Air Traffic Service's Airspace Management Program Office (ATA) is currently involved with RTCA, National Aeronautics and Space Administration (NASA) and representatives from the user community in completing the actions defined in the National Airspace Management Plan, published in July 1997. The overall objective of the plan is to improve airspace management and provide more effective and efficient use of the NAS airspace for all users. The current airspace structure is based primarily on the availability of navigation aids and surveillance facilities. The future airspace structure will be designed to facilitate Free Flight initiatives. This includes the application of dynamic airspace allocation, which enables ATC to adjust controller airspace assignments to meet changing traffic needs, not based on the ground navigation and surveillance structure. In addition, applications may be required for operations above 50,000 feet where no ATC operations exist (unmanned flying objects and commercial space operations). All of the activities require ATC surveillance in order to provide ATC services efficiently and ensure safety for all users.

2.2 International Civil Aviation Organization (ICAO) and International ADS-B Actions. The international aviation community and ATC service providers are actively engaged in the research and development of ADS-B technology to facilitate surveillance information availability throughout the world's airspace. The international availability of ground surveillance systems (terminal and en route radar systems) is limited. Maintenance costs and the cost of implementing new ground surveillance systems is significant for many countries. As a result, many countries and international aviation industries are involved in developing ADS-B technological applications and plans for integrating them into the ICAO initiatives. European states and aviation companies have installed and are testing ADS-B avionics and are evaluating this enhanced surveillance information.

2.3 Safety. The enhanced surveillance or ADS-B technological contribution to augment safety has significant potential in air-to-air, airport surface, and air-to-ground enhanced surveillance areas. Depending on the ADS-B applications developed, the enhanced surveillance information will provide major advantages in conflict and hazard detection, as well as avoidance processes in all weather conditions. ADS-B technological applications significantly enhances the "see and be seen" flight and ground operations. The capability to use real-time information and knowledge about an aircraft, flying objects, and vehicle intentions/movements significantly improves safety. Increased safety can result from:

a. Expanded and improved situational awareness of ATC controllers, dispatchers, en route flight advisory service, pilots and airport vehicle operators in all three domains (en route, terminal, and surface)

b. Providing airborne conflict management to include detection, prevention and resolution of traffic

c. Expanded and improved flight crew situational awareness of other aircraft climbing, descending, and in level flight

d. Providing surveillance in non-radar surveillance airport surfaces (blind spots and non-radar airports)

e. Providing surveillance in non-radar surveillance airspace (blind spots, non-radar surveillance airspace, mountainous terrain and oceanic airspace)

f. Expanded and improved situational awareness of aircraft and airport vehicles on the airport surface (arriving and taxiing aircraft and vehicles on the movement area)

g. Improved visibility on the airport movement area for aircraft and vehicles in inclement weather and night operations

h. Expanded and improved situational awareness of flight obstacles (high towers, buildings, and objects infringing into airspace for flight).

2.4 Capacity. The use of technological applications to expand and enhance surveillance information in ATC supports FAA initiatives to meet increased demands on system capacities in an era of reduced resources. Expanded surveillance coverage and increased accuracy regarding position information (both in the air and on the ground) provides the FAA the opportunity to develop new procedures and processes to promote improved air traffic throughput and management.

2.4.1 Improved Position and Intent Information. Improvements over present-day surveillance will be accomplished when aircraft position and intent data available from on-board aircraft avionics are combined with aircraft position information available from other surveillance systems. This information supports the decision processes related to conflict detection and avoidance situations. In areas where all participants are equipped, the increased accuracy of this enhanced surveillance, its higher update rate, and the additional parameters it supports (such as aircraft intent) may enable the reduction of separation standards and hence increasing airspace capacity and throughput.

2.4.2 Non-Surveillance Airspace. The separation criterion in non-surveillance airspace is minutes of flying time. As an example in the en route non-surveillance airspace, two aircraft flying at the same altitude, in the same direction, at 420 knots are separated by 10 minutes or 70 miles (7 miles per minute X 10 minutes). Separation criteria for non-surveillance (non-radar) airspace has a significant impact on the capacity of the NAS. The application of procedures incorporating the use of enhanced surveillance information enables a greater use of the airspace capacity. As an example, the en route situation described above may allow the aircraft to be separated by 5 miles thereby freeing 65 miles of airspace for other users. Enhanced surveillance criteria are yet to be defined. However, anything less than the 70 miles between aircraft is an improvement.

2.4.3 Procedures. Procedural restrictions (related to use of non-radar procedures), when modified to incorporate enhanced (ADS-B) surveillance capabilities, can increase the volume of traffic which can be processed during poor visibility conditions. With enhanced surveillance reports ATC will be able to provide surveillance functions in non-radar airspace.

2.4.4 Airport Landing Capacity. Technological application of this enhanced surveillance augments existing ground based system performance capability and offers the opportunity to extend capabilities to non-radar locations. Enhanced surveillance capability in all types of weather conditions will result in fewer missed approach delays, increased operational safety, and reduced controller workload. As an illustration, during Visual Flight Rules (VFR) conditions and multiple aircraft on approach, controllers issue instructions to visually identify an aircraft and follow it until it lands. In today's environment, approach slots are lost due to visually identifying the wrong aircraft to follow or by getting too close to the preceding aircraft causing ATC to issue go-around instructions. In an enhanced surveillance environment the following aircraft system would clearly identify and display the preceding aircraft and update the pilot with speed, direction, and altitude information enabling the following aircraft to maintain the proper distance.

During reduced visibility and Instrument Flight Rules (IFR) conditions, the increased approach and situational awareness provided by ADS-B technology will allow for continued use of closely spaced parallel runways. This eliminates the need to reduce airport arrival operations from two runways to one, thus increasing (restoring) airport capacity in limited visibility conditions.

2.5 Efficiency. Safely increasing the capacity of the NAS can bring about (at a minimum) proportional increases in the aerospace industry operational capability without adding additional resources. Cost savings resulting from reduced operating costs (e.g. fuel savings, fewer delays, noise, etc.) and better use of resources will provide long term benefits. Cost savings and operational benefits can be expected to offset the cost to equip aircraft.

Free Flight envisions major economic benefits to be derived from capacity improvements for all users of the NAS airspace. Improving the use of the NAS airspace, airport utilization, and maximizing the use of existing airport facilities will lowers user-operating costs. This should provide the potential for better on-time performance.

2.6 Business Productivity. Enhanced surveillance capability provides substantial productivity gains for the FAA. Productivity improvements in the management of traffic result from the increased accuracy of positional and intent information. Problems and risks associated with identification, tracking, and controlling activity in the air and on the ground will be reduced.

Air Traffic Service (ATS) providers could realize cost savings from implementation of an enhanced surveillance system. Replacement, upgrade, and maintenance of the existing aging radar-based surveillance infrastructure are expensive undertakings. If the users are equipped with ADS-B avionics as we anticipate, it may be feasible to decommission some Secondary Surveillance Radars (SSRs) when those SSRs are near the end of their economic service life. Because ADS-B ground stations can use simple omnidirectional or sectored antennas and receivers, they should be substantially less expensive than SSRs to acquire and maintain. This added efficiency could result in less FAA operational costs for higher volumes of traffic. From an economic perspective, costs for ADS-B ground stations can be expected to be offset by the cost avoidance of ground-based radar surveillance costs. Reduced NAS surveillance service life cycle management costs and increased NAS capabilities will produce a favorable return to the FAA and aviation users.

3.0 NEEDED CAPABILITY

FAA Office of Aviation Policy and Plans (APO) workload and aviation activity forecasts for FY 98 - 09 show a substantial air traffic increase within the continental U.S. The ATS Concept of Operations (CONOPS) defines the need for increased Air Traffic Management (ATM) services because of the additional traffic growth. The impetus for the FAA needs is based, in part, on the increasing demand (traffic) and the benefits to be derived by transition of the NAS toward Free Flight. Another driving factor is the safety objectives in an increasingly crowded airspace.

Defined needs are grouped into the three broad categories:

- Enhanced surveillance information for ATC
  - ➢ Enhanced separation assurance
  - ➢ Enhanced traffic flow
- Enhanced situational awareness
  - ➢ Enhanced advisory services
- Technological opportunity of ADS-B.

The enhanced surveillance needs concentrate on expanding surveillance coverage to areas that do not have surveillance and to increasing the accuracy of the surveillance data for decision support tools, allowing improvements in procedures. In this area the fundamental need is to increase air traffic controller awareness of in-flight aircraft status and aircraft movement on the ground.

The enhanced situational awareness needs are to aid the controllers, pilots, and vehicle operator performance by providing additional situational information.

3.1 Enhanced Surveillance Information in ATC

The FAA ATC systems rely on terminal and en route radar systems for surveillance information. Both terminal and en route surveillance coverage are limited to varying degrees by blind spots and non coverage areas due to the effects of obstructions to the electronic surveillance process by trees, buildings, towers, and terrain. Ground receiver sites can easily be located on high places (for example: rooftops, hilltops, etc.) to avoid blind spots and obstructions.

According to the *Joint Government/Industry Roadmap for Surveillance Modernization* the Air Traffic environment of the future will be increasingly dependent on more accurate and timely information being available to Air Traffic (AT) service providers and aircraft operators. Information pertaining to a variety of airspace conditions and accurate position data, including aircraft intent, will be necessary. This data will need to be shared between service providers and users efficiently. Surveillance data will be a key ingredient in this paradigm of information sharing. Improved decision tools will be able to take advantage of aircraft intent information to provide more accurate situation awareness. Together with improved accuracy, this will allow for more accurate trajectory modeling for use in conflict prediction and resolution, metering applications, and spacing tools. In addition, sharing the surveillance information with the cockpit will increase the pilot's situational awareness, reducing the need for requests for information, and will enable the use of cockpit-based procedures that safely support efficiency and capacity goals.

3.1.1 The FAA ATC personnel require reliable, accurate, timely and cost efficient surveillance information of aircraft, flying objects, and vehicles operating in the airspace from the ground up. This information needs to be available in all types of terrain, in current non-surveillance airspace areas and oceanic control areas, without blind spots or areas of non-coverage. Theaccuracy of information needs to be sufficient to safely increase existing airspace capacity. A reliable surveillance system is imperative for ensuring separation assurance.

3.1.2 ATC personnel need reliable, accurate, timely and cost efficient surveillance information for all aircraft and vehicles operating on the airport surface movement area in all weather conditions.

3.1.3 In order to dynamically adjust traffic flows, reliable, accurate, and timely information is essential.

3.1.4 With the advent of space operations, ATC personnel need surveillance information on flying objects above current ATC surveillance systems capabilities.

3.2 Enhanced Situational Awareness

3.2.1 The users of the airspace rely primarily on a "see and be seen" concept, together with ATC services, in order to gain a situational awareness of the other users around or near them. It is necessary to provide an accurate, timely, and efficient means to receive advisory information to increase the situational knowledge of airspace users, so that they can operate efficiently and increase safety to flight.

3.2.2 At the airport, pilots and vehicle operators rely on the same "see and be seen" concept together with ATC services for moving about the airport surface movement area and to gain a situational awareness of other aircraft and vehicles around or near them. Pilots and vehicle operators need an accurate, timely, efficient means to increase their situational knowledge of the other users around or near them in order to operate their aircraft efficiently and increase safety in the airport movement area.

3.3 ADS-B Technology Opportunity

This Enhanced Surveillance MNS provides for the integration of ADS-B technology information in the three areas of air-to-air, air-to-ground, and airport surface. Along with addressing the needs in the three areas, there is a predominant need for the FAA to be compatible with international systems that are now planning to use this technology.

Air-to-air is discussed in this MNS because ADS-B technological implementation in both the air-to-ground and the airport surface domains depend on the aircraft avionics equipage. Aircraft Certification Services (AIR) and Flight Standards Services (AFS) have addressed many of the FAA mission needs for enhanced surveillance (ADS-B) air-to-air component, in MNS 172; Flight Operations and Air Traffic Management Integration (FTMI), October 21, 1994. Also, the aviation industry under the leadership of RTCA is working with the FAA to develop benefits and costs for various ADS-B applications that impact safety and capacity. From an equipment acquisition viewpoint, air-to-air is an industry responsibility. FAA's responsibilities in the air-to-air area involve policy, certification, and the implementation of supportive air traffic procedures for the use of enhanced surveillance capability provide by ADS-B technology in the NAS.

3.3.1 Air-to-air. Capabilities required in the air-to-air area include:

a. Ability of the aircraft to accurately determine current location during all phases of flight

b. Ability to regularly broadcast current location in a timely and efficient manner without the need for any active interrogation from other aircraft

Note: This capability of broadcasting one's own position is a fundamental prerequisite to all other capabilities in all domains.

c. Depending on the class of airspace and status of equipage, ability of ADS-B equipped aircraft and flying objects to passively receive ADS-B broadcasts from other ADS-B equipped aircraft and flying objects

d. Depending on the class of airspace and status of equipage, ability of aircraft and flying objects to process and display the proximate aircraft location information to the pilot, as it relates to the pilot's own aircraft.

3.3.2 Airport Surface. Capabilities required in the airport surface areainclude:

a. Ability of the aircraft and all vehicles on the surface runway movement area to accurately determine their current location at all times

b. Ability of aircraft on the airport surface runway and enhanced surveillance (ADS-B) equipped vehicles to transmit enhanced surveillance (ADS-B) broadcasts to other enhanced surveillance (ADS-B) equipped aircraft while flying on approach, departure and near the airport surface area

c. Ability of aircraft and vehicles operating on the airport surface to receive this enhanced surveillance (ADS-B) broadcasts and determines other vehicle locations in relation to their own location.

3.3.3 **Air-to-Ground.** Capabilities required in the air-to-ground area include:

a. Ability for ground equipment to receive enhanced surveillance, ADS-B messages from aircraft operating in the operational area of interest and forwarding these messages to ATC automation equipment

b. Ability to provide controllers with surveillance data positions of all aircraft, flying objects, and vehicles, based on accurate, reliable, and timely surveillance data sources. Surveillance data sources include terminal and en route radar and beacon systems, ADS-B broadcasts, and any other FAA data source.

4.0 CURRENT AND PLANNED CAPABILITY

4.1 Air-to-Air Surveillance Capabilities.

4.1.1 Current Air-to-Air Surveillance Capabilities. There is no current civilian air-to-air surveillance capability. The closest such capability which exists today is the Traffic Alert and Collision Avoidance System (TCAS) which is not considered a surveillance system and is not used as the basis of separation, but is a collision avoidance system. TCAS provides a warning of proximity indication to the flight crew on passenger carrying aircraft with ten or more passengers. thereby support collision avoidance.

4.1.2 Planned Air-to-Air Surveillance Capabilities Each equipped aircraft regularly broadcasts its own positional information and other message set information.Other aircraft within range may receive this data and use it for surveillance purposes. Some enhanced surveillance air-to-air applications will be implemented in FY 00. This is the first domestic U.S. surveillance capability for appropriately equipped aircraft. During FY 99 independent air carrier and air cargo initiatives and cooperative research and development programs, such as Safe Flight 21, started the evaluation of ADS-B technological applications in selected test scenarios. Flight evaluations are also continuing in Europe.

4.2 Air-to-Ground Surveillance Capabilities

4.2.1 Current Air-to-Ground Surveillance Capabilities. The FAA currently provides air-to-ground surveillance support to the NAS with a wide variety of radar systems in the en route and terminal domains.

En route air-to-ground surveillance is currently provided by Air Route Surveillance Radar (ARSR), models ARSR-1/2/3/4. En route air-to-ground secondary surveillance is currently provided by the ATCBI, models ATCBI-3/4/5, as well as the Mode S sensor.

In the terminal domain, air-to-ground surveillance is provided (at those airports with a radar approach control) by Airport Surveillance Radar (ASR), models ASR-7/8/9. Terminal air-to-ground secondary surveillance is currently provided by the ATCBI, models ATCBI-3/4/5, as well as by Mode S sensors.

In the oceanic air-to-ground environment, there are no current capabilities for surveillance. Oceanic surveillance is currently accomplished on a limited basis (for one oceanic sector in the Oakland Oceanic Control Center) using Automatic Dependent Surveillance-Addressed (ADS-A) avionics with vendor-provided satellite communications relaying the data from the aircraft to the ground. ADS-A is based on a negotiated one-to-one peer relationship between an aircraft providing ADS information and a ground facility requiring receipt of the ADS messages. Note that ADS-A provides no air-to-air surveillance capability between aircraft.

4.2.2 Planned Air-to-Ground Surveillance Capabilities. According to the NAS Architecture (Version 4), the FAA is evolving to a surveillance system using radar systems and enhanced surveillance (ADS-B). Secondary Surveillance Radar (SSRs) will continue to be used to enable the ATC system to maintain full service whenever there is difficulty with the satellite-derived position information or individual ADS-B avionics. Primary radars (skin reflective radars) will be phased out of en route airspace between 2001 and 2005. En route air-to-ground secondary surveillance will be provided by the ATCBI, model ATCBI-6, as well as the Mode S sensor. In addition to SSR, the FAA plans to provide enhanced surveillance (ADS-B) for future en route air-to-ground surveillance.

Starting in FY1999, independent air carriers, air cargo carrier initiatives, and cooperative research and development programs, such as found in Safe Flight 21 and Capstone Project, conducted evaluations of this enhanced surveillance air to ground ADS-B operations and procedures in selected test scenarios. The Safe Flight 21 program, which is tied to joint FAA and RTCA objectives, is scheduled to continue for the next several years.

Starting in 1999, a new system (ASR-11) will be deployed as a replacement for ASR-7s and 8s and will complement the ASR-9/Mode-S system. Air-to-ground surveillance will be provided at those airports with an ASR, models ASR-9/11. In addition, the FAA is planning to use ADS-B technological applications to provide terminal domain air-to-ground surveillance capabilities.

In the oceanic air-to-ground environment, ADS-A will continue to be used, but with expanded sector coverage. However, as stated in paragraph 4.2.1 above, enhanced surveillance (ADS-B) is also planned to provide air-to-air surveillance in the oceanic environment.

4.3 Airport Surface Surveillance Capabilities

4.3.1 Current Airport Surface Surveillance Capabilities. ASDE-3 provides radar surveillance of aircraft and vehicles on airport taxiways and runways at only 34 high-activity airports (Level 4 & 5). Radar monitoring of surface operations (ground movement of aircraft and vehicles) provides a means of directing and moving surface traffic. This is especially important during periods of restricted visibility such as rain, fog, and night operations. ASDE-3 is subject to multi-path issues, which may reflect several targets for one actual target. The ASDE-3 system is also subject to having blind spots due to obstructions causing non-surveillance areas

4.3.2 Planned Airport Surface Surveillance Capabilities. On the airport surface, ADS-B technological applications will provide surveillance. In addition, at the 34 high activity airports, surveillance capabilities will be provided by ASDE-3 with Airport Movement Area Safety System (AMASS) as a near-term implementation. AMASS will add an automation enhancement to the ASDE-3 to provide conflict alert algorithms for tower controllers to detect and prevent collisions and accidents. The FAA also has a major new initiative: the ASD-X program for surface surveillance management. The ASD-X has the capability to receive surveillance data (radar, ADS-B, etc) and fuse that data for surveillance use. According to the NAS Architecture the FAA is also considering initial Surface Movement Advisor (SMA) for implementation in 2006-2007. SMA provides a one-way feed of arriving traffic information from the approach control automation system to ramp control computers for use by airline personnel. The SMA primary users are airline operations activities for ramp control issues. There is limited planned runway incursion protection at most of the other approximately 5400 public use airports, which includes a range of airports from medium size "hub and spoke" airports to those airports that may not have control towers. The FAA is reviewing research and development opportunities by exploring new technologies to resolve runway incursion problems.

5.0 CAPABILITY SHORTFALL/TECHNOLOGICAL OPPORTUNITY

5.1 Technological Opportunity. ADS-B provides the technological opportunity to dramatically improve and expand surveillance capabilities.

5.1.1 More Accurate Positional Information. ADS-B provides GPS-based position and altitude information, which is much more accurate than today's radar-based positional information. Radar-based positional information becomes progressively less accurate the further the target is from the active sensor because of angular uncertainty. ADS-B position data has no such distance-related inaccuracies. ADS-B also provides the ability to receive accurate GPS-based geodetic altitude information, rather than atmospheric pressure-derived altitude.

5.1.2 Additional Aircraft Information. ADS-B supports the broadcast of aircraft-related information that is not currently available from any surveillance sensors, such as aircraft speed, intent, turn indication and rate, climb indication and rate, and aircraft call sign and status information along with additional message set information. This additional information supports procedures not possible today. Intent data, (future speed, heading, or altitude changes) could be extremely valuable in collision avoidance or conflict detection applications.

5.1.3 Ability to Expand Surveillance Coverage at Lower Cost. The projected low cost of ADS-B avionics and ground stations provides the opportunity for implementing cost-effective coverage in areas not presently covered by surveillance systems. The current surveillance technologies suffer from line-of-sight limitations, range limitations, shielded areas, blind spots, and loss of coverage due to curvature of the earth. Such areas could include low altitude airspace, remote en route areas, non-radar approach airports, and airport surface areas not covered by ASDE. This could allow the use of radar-like separation procedures in non-radar areas.

5.1.4. **Shared Situational Awareness and Aircraft Information.** The key to enhancing NAS safety, efficiency, and capacity is to provide better situational awareness to participants in the air, on the ground, and on the airport surface. Participants include controllers, pilots, vehicular operators, and dispatchers. Situational awareness of aircraft information plays a part in all NAS capabilities. Providing "shared" situational awareness information to all participants would facilitate aircraft/vehicular movement in the air and on the airport surface.

In addition, augmenting surveillance capabilities with ADS-B will allow the implementation of many unique ADS-B applications. The RTCA Minimum Aviation System Performance Standards (MASPS) for ADS-B lists over 70 potential applications that could be implemented. ADS-B is an enabling technology - the benefits will result from the operational applications and the corresponding concepts, algorithms, procedures, standards and user training.

5.2 Capability Shortfall. Using the technology capabilities discussed above, enhanced surveillance utilizing ADS-B applications, has the potential to satisfy stated agency and aviation community needs in air-to-air, airport surface, and air-to-ground areas. Improvements to these areas impact the capacity and safety of the NAS.

5.2.1 Capacity. Currently traffic is limited in situations where demand exceeds capacity. Stated another way, dynamic density predictions exceed thresholds for controller/decision support system ability to safely handle a given volume and pattern of traffic. In this environment, ATC institutes procedural restrictions resulting in a reduced level of service (e.g., reduced flexibility and access, and increased delays). Costs to airlines affected by current NAS capacity limitations and inefficiencies are estimated at $3.5 billion per year according to the Final Report of RTCA Task Force 3. Recent data from the "National Civil Aviation Review Commission Report" indicates the delay problem is getting worse. The number of daily aircraft delays of 15 minutes or longer was 18.9% higher in 1996 than in 1995. In addition the Air Transport Association (ATA) reports that the amount of time per delay rose 10% between 1995 and 1996. The primary cause for delays over an eight year (1986 through 1994) period was weather 66% and terminal volume 22%. The delays are increasing. For a period from June 1 to 28, 2000, delays were up 6,000 from a year earlier, for a total of 44,000 delays.

As demand increases, maintaining safety will force increasing reliance on costly traffic limitations in situations where demand exceeds capacity. As demand increases further, regulatory measures will no longer suffice to provide the requisite level of service. As stated in the NAS Architecture, the demand for NAS services is growing--new capabilities must include functions needed to support growth in traffic.

Enhanced Surveillance utilizing ADS-B technology has the potential for significant positive impact on capacity using a number of different applications as stated in the MASPS. The JRC approved MNS, En route/Oceanic Domain (MNS 309) identifies five areas that are deficient in the current system.Two of the areas, capacity and efficiency, specifically state the need for new surveillance technologies and improved surveillance processing.

5.2.2 Safety. Surface detection equipment in support of airport surface operations is deployed at only the 34 busiest airports and is used to monitor surface movement. Enhanced surveillance MNS has the potential to extend the benefit of surface surveillance (e.g., increased surface situational awareness and enhanced airport surface operations in all types of weather conditions) to airports where ASDE-3 was not implemented due to the high cost of radar equipment. ADS-B surface enhanced surveillance could be achieved for a reduced cost in comparison with ASDE. Historical data indicate a recent increase in the rate of runway incursions even as the number of airport operations has decreased (See Table 1). In the five years from 1993 and 1997 there was a 67% increase in the runway incursion rate per 100,000 airport operations. Preliminary estimates indicate ADS-B would increase situational awareness to the controller, vehicle operator and pilot, and may provide additional alert time over any current approach.

Table 1: Runway Incursion Data

Calendar Year	No. of Runway Incursions	No. of Airport Operations	Runway Incursion Rate (per 100,000 Airport Operations)
1993	186	61,946,482	0.30
1994	200	62,452,572	0.32
1995	240	62,074,306	0.39
1996	275	61,817,425	0.44
1997	292	64,440,947	0.45
1998	325	66,218,975	0.49
1999	321	68,684,037	0.47

The overall number of reported critical near midair incidents decreased substantially over the past ten years; however, the preponderance of the incidents reflects several typical situations in which ADS-B technology has potential benefits. As portrayed in Table 2 and Table 3, the majority of the critical incidents within U.S. airspace occur in the period of transition between one class of airspace and another or when aircraft are operating under different flight rules (e.g., VFR aircraft approach IFR aircraft). A review of two years of critical near midair incident report narratives reveals an inability to locate "see and avoid" the other aircraft in sufficient time to preclude a critical situation. Aircraft equipment will have the capability to broadcast location and electronically "see and avoid" other aircraft with advanced warning that will enhance flight safety. Analyses of critical near midair collisions show that ADS-B used as a situational awareness tool has the potential to reduce the criticality of the Near Midair Collisions (NMAC) by 78% over the current non-ADS-B environment. Analysis of National Transportation Safety Board (NTSB) data indicates ADS-B has the potential to reduce actual midair collisions by 71% if enhanced surveillance (ADS-B) were available for situational awareness. This translates to 14.7 fewer midair collisions per year and 25.3 fewer fatalities per year.

Table 2: Percentage of Critical Near Midair Incidents Reports by Rules of Flight

Rules of Flight	IFR - IFR	IFR - VFR	VFR - VFR
Near Midair Incidents Percent	6.4%	55.3%	38.3%

Table 3: Percentage of Critical Near Midair Incidents and Actual Midair Accidents Reported by Airspace Type/Class

Type of Airspace	Controlled			Uncontrolled	Special Use Airspace
Class of Airspace	A	B/C/D	E	G	SUA
Critical NMAC Incidents %*	2.1%	42.5%	27.7%	23.4%	4.3%
Actual Midair Accidents **	0%	36.2%		62.2%	1.6%

* Percentage based on review of 1996/1997 Critical NMAC reports. ** Based on fifteen years of data.

6.0 IMPACT OF NOT APPROVING THE MISSION NEED

In the "*Final Report of RTCA Task Force 3 - Free Flight Implementation*", published by the RTCA in 1995, with the FAA and industry stakeholders, identified ADS-B as a key enabling technology component of the concept of Free Flight. Again in 2000, the *Joint Government/Industry Roadmap for Surveillance Modernization* identified ADS-B as a "cornerstone" of the future surveillance system. The Task Force 3 report outlined 44 recommendations for consideration in implementing Free Flight, at least six of which had to do with the development of ADS-B architecture, ground infrastructure and automation capabilities. Disapproval of this MNS will place the implementation of the Free Flight concept in jeopardy. Other major impacts of not approving this MNS include:

a. Current surveillance in today's environment will not support the projected continued aviation growth. As the traffic load increases the air traffic controller workload will also increase. This workload increase will result in system delays and increased (not decreased) separation will be required for safety and effective traffic flow throughout the NAS. Restriction in traffic flows across the NAS will result in increasing cost to NAS users and NAS service providers. Without an influx of new technology the existing surveillance coverage will be insufficiently robust to achieve the demands of increased aviation growth.

b. The inability of the FAA to keep pace with the international communities that are planning or in the process of implementing this technology. The ramification of the first impact affects the capability to provide ATS services that will enable the FAA to handle projected growth and NAS modernization in an austere fiscal environment. The magnitude of the impact of not keeping pace with the international community ranges from on-aircraft equipment incompatibility for aircraft using different aircraft control services while flying international routes to a potential loss of competitive position for the U.S. aviation industry abroad.

7.0 BENEFITS

Approval of the Enhanced Surveillance (ADS-B) MNS will provide the FAA and the aviation community direct benefits resulting from:

- Expanded and improved situational awareness by air traffic controllers, dispatchers, en route advisory service, pilots, and airport vehicle operators
- Expanded and improved flight crew situational awareness of other aircraft
- Increased surveillance in non-radar airspace
- Increased surveillance in non-radar airport surfaces
- Increased capacity through reduced aircraft separation requirements
- Improved use of airspace resulting from the ADS-B technological applications contributions to the enabling of free-flight.

Enhanced surveillance (ADS-B) direct benefits can be shared by both the service providers and the aircraft operators

7.1 Safety. Aircraft equipped with this enhanced surveillance will have the capability to broadcast their own location, and receive location information from proximate aircraft, flying objects and airport vehicles, allowing them to electronically "see and avoid" other aircraft with advanced warnings. As stated in paragraph 5.2.2, analysis of critical near midair incident reports show that ADS-B technology applied as a situational awareness tool has the potential to reduce the criticality of the critical NMAC by 78%, and to reduce the actual midair collisions by 71% over the current non-ADS-B environment. Enhanced surveillance (ADS-B) will also assist in visually acquiring proximate aircraft, reducing the time needed to perform visual search scans, and eliminating the possibility of misidentifying other aircraft in approach patterns. Also, enhanced surveillance (ADS-B) will help the en route flight advisory service (EFAS) personnel to locate general aviation pilots and provide better information (such as weather status data).

In the airport surface environment, the situational awareness that this enhanced surveillance provides to aircraft, flying objects, airport vehicles, and controllers, will greatly contribute to a reduction in runway incursions as well as collisions at airports without towers.

7.2 Capacity. In numerous terminal areas, enhanced surveillance, ADS-B technological applications, will support improved all-weather operations in the air and on the ground. At airports, arrival and departure capacity decreases with inclement weather conditions, in some cases dramatically reducing airport capacity. Airport capacity may be increased under all visibility conditions through the use of enhanced surveillance and improved situational awareness and conflict detection automation.

Enhanced surveillance (ADS-B) can benefit the aviation community that operates today from smaller, non-radar-controlled airports. Radar coverage at certain airports terminates at altitudes above the airport surface (e.g., radar coverage at Jackson Hole, Wyoming terminates below 13,000 feet mean sea level). Installation of a low-cost ADS-B ground station at Jackson Hole airport and linking the data to Salt Lake City ARTCC (which presently provides ATC services for the airport) could be accomplished at a small fraction of the cost of a conventional radar installation. By increasing the surveillance of the airspace below 13,000 feet, both arriving and departing aircraft could be expedited at the airport, saving significant delays.

In the oceanic, en route, and terminal environments, reduced separation minima will allow more aircraft to fly at their optimum altitude, speed, and routing. Enhanced surveillance (ADS-B) can provide air-to-air surveillance over the oceans, which may allow for a reduction in latitudinal and longitudinal separation.

7.3 Efficiency. In the oceanic, en route, and terminal environments, the increased flexibility and accessibility through reduced separation minima will allow more aircraft to fly at their optimum altitude, speed, and routing, resulting in improved economic costs to the user. For example, an American Airline study outlined the impact of projected air traffic growth upon future traffic capacity. The purpose was to establish a common foundation for understanding the economic impact on scheduled airline operations. Several of the study objectives were to project the impact in delays (cost and lost revenue opportunity) and airspace congestion. Using conservative assumptions in analyzing the industry study showed a total annual benefit value for capacity improvements.

Additional benefits in the terminal area are possible for service providers and gate operators and may be achieved through better scheduling of services. Economic benefits can be realized through resource tracking and managed deployment of resources. Gate managers using precise information on aircraft location will be better able to schedule and allocate parking slots, fuel and food deliveries, and pilot assignments.

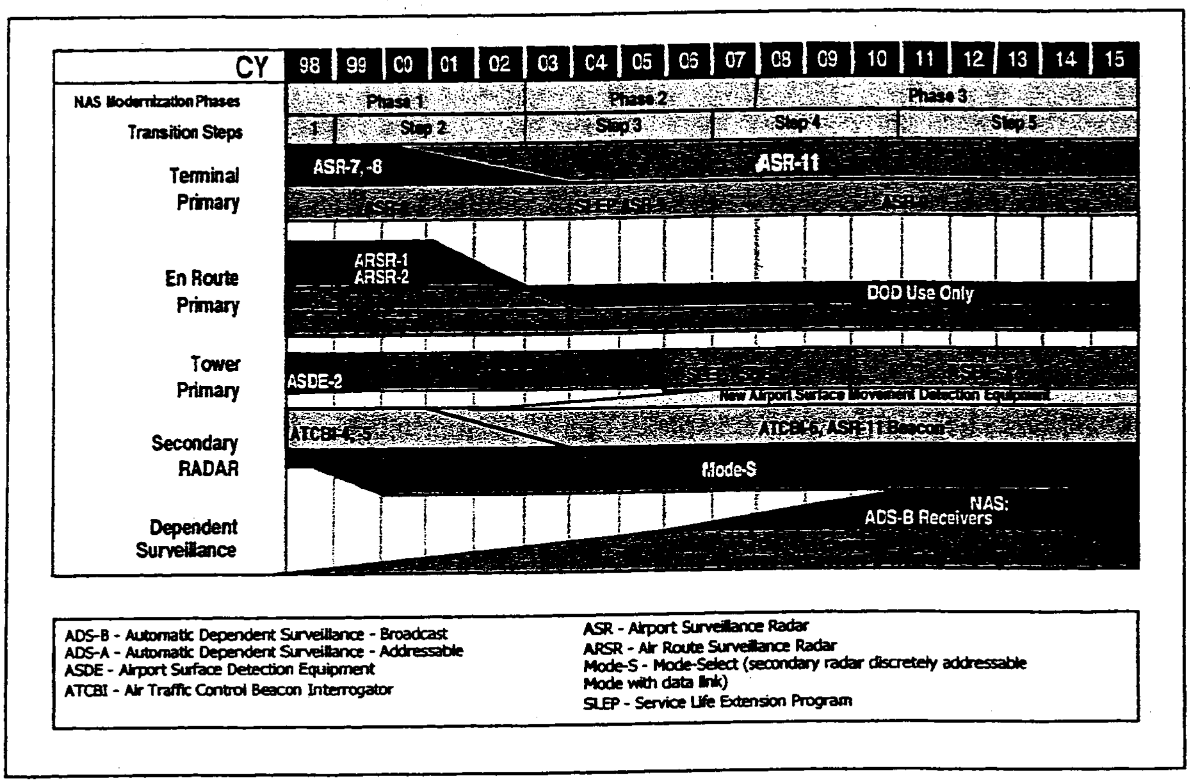
7.4 Business Productivity. Economic benefit through the use of enhanced surveillance will be realized in several areas. Improved airport utilization made possible by ADS-B technological applications will maximize the use of existing airport facilities, lower operating costs, may reduce the need for airport expansion, and potentially provide better on-time performance.

Substantial cost avoidance can result from the implementation of an enhanced surveillance (ADS-B) system. For example, ADS-B technology can be effectively used to establish surveillance in remote locations or to extend surveillance capabilities with advantages in cost, coverage, and performance when compared to extending current ground-based surveillance for the same functions.
Significant cost savings can result from the replacement and decommissioning of unnecessary primary and (selected) secondary radar and associated surveillance equipment and Class I navigation systems and resources.

8.0 TIMEFRAME

The NAS Architecture and the ADS-B roadmap define a proposal for how the NAS will likely evolve over the next 20 years. Outlined below is the NAS surveillance transition. Included in this evolution is a transition schedule for the proposed surveillance architecture including ADS-B.

Figure 1 NAS Architecture Surveillance Transition



The principle transitions for ADS-B are:

2000-2008	Based upon air-to-air surveillance, provide enhanced terminal approach/departure and oceanic maneuvering services
2000-2005	Develop improved air-to-air surveillance systems and ground stations via ADS-B pilot programs
2005-2010	Deploy passive ADS-B ground stations
2005-2009	Extend en route surveillance coverage to new areas
2005-2010	The NAS Architecture and the ADS-B roadmap defines a proposal for how the NAS will likely evolve over the next 20 years.

9.0 CRITICALITY

The White House Commission on Aviation Safety and Security mandated that by the year 2005, the modernization of the nation's aviation infrastructure be completed. In response, the FAA and industry have begun aggressive initiatives to integrate proposed modernization programs into the NAS. The Commission recommended that in the area of safety, the principal focus should be on reducing the rate of accidents by a factor of five within a decade. The Commission recognized that historically, major advances in aviation safety have been driven by technological improvements. The Administrator has incorporated these mandates as strategic objectives in the FAA Strategic Plan. ADS-B provides a technology opportunity to effectively support the safety objectives.

One objective of the FAA is to actively promote U.S. aviation system technologies, products, and services internationally. International initiatives are already underway to develop and deploy automatic dependent surveillance systems. For example, Eurocontrol, the Swedish Civil Aviation Administration (CAA), and others are working with ADS-B technology. In light of these and other international initiatives, the U.S. risks surrendering technical leadership in a potentially lucrative and growing market. This will adversely affect the ability of U.S. avionics manufacturers and software companies to compete for international product markets. In addition, to ensure uninterrupted, seamless operation worldwide, ADS-B will require international harmonization, including ICAO Standards and Recommended Practices (SARPS). Consequently, a U.S. failure to proceed with ADS-B implementation may lead to lack of global interoperability.

10.0 NAS ARCHITECTURE ESTIMATE

A Rough Order of Magnitude (ROM) Benefit and Cost Analysis was prepared for this MNS. The ROM identified three primary benefit areas: safety, capacity, and efficiency. The ROM established a projected upper range for the enhanced surveillance resource allocation based on like/similar programs analysis combined with available industry projections. The NAS architecture Version 4.0 planning resource estimates were used as the estimated cost for enhanced surveillance (ADS-B) acquisition and implementation. The numbers in the chart below do not reflect the avionics costs.

Table 4: NAS Architecture Estimate

ADS-B Costs in Current Year ($K)	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 08-25	FY 26-35	Total
F&E Total	41,326	37,494	39,156	34,581	46,905	66,797	1,364,444	305,199	1,935,901
O&M Total	673	982	2,620	4,425	6,162	9,960	782,591	509,913	1,317,326
Total	41,999	38,475	41,776	39,006	53,066	76,757	2,147,035	815,112	3,253,227